Stewart
File
Ellison

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
TROPICAL FOREST EXPERIMENT STATION

ADDRESS REPLY TO
DIRECTOR
AND REFER TO

R - TR
REPORTS
Annual

RIO PIEDRAS, PUERTO RICO

January 28, 1946

Gen 8
E

ANNUAL REPORT AND PROGRAM

TROPICAL FOREST EXPERIMENT STATION

CALENDAR YEAR 1945

ANNUAL REPORT AND PROGRAM

Calendar Year 1945

The forest problem, from the standpoint of both research and the improvement and management of public and private forest lands in Puerto Rico, is quite clearly understood and has been described in previous reports. No new aspects of the problem have appeared during 1945.

Research has gone steadily forward the past year, 90% of which was in the fields of silviculture, forest mensuration and artificial regeneration, and resulted in specific helpful findings. And the usual lag between progress on or the completion of each investigative job and the application of the results in the improvement and management of natural forest stands and the establishment of young forests on public lands, has disappeared to such an extent that it is difficult to determine where the research stops and the technical forest management begins.

The current research program requires at this time, not reorientation, but expansion to include silvics in full fashion, and extension to include certain phases of forest economics and forest utilization. For Puerto Rico alone, the dendrology is a nonrecurrent job possible of completion in two or three years and thereafter kept current, with other phases of silvics to continue a longer time. Forest economics, also a nonrecurrent job as now planned, should comprise a systematic survey of present and potential forest resources of the Island and a land management and use study and program which could be completed in two or three years. Forest utilization would comprise a new series of studies of the uses and

local requirements, and simple property and application tests of Puerto Rican woods, opening an avenue of contact between the Station and the Forest Products Laboratory, and a technical service to local specifiers and consumers of wood.

An expanded and extended program of the foregoing character will aggressively attack the more important parts of the Island's forest problem, that is, it will:

1. Provide a long-time land-allocation or land-use plan for the Island and through the application of the provisions of that plan (a) all lands which are now idle because of low natural quality or degradation from man's use can be made productive of the forest materials, which are sorely needed on the Island, and productive of work opportunities, the present lack of which is one of the Island's most serious problems, and (b) will arrest the misuse and abuse of land to the benefit of all the people, the water resources, the stability of crop agriculture, and the outdoor recreational values of the Island.
2. Determine, short of the precise forest products research which should be done at the Madison Laboratory, the natural timber species which will best serve the Island's wood products requirements and the methods of their manufacture, processing, or treatment which will best meet the requirements of their uses as charcoal and fuelwood, for rural rustic house construction and small farm timbers, and for narrow-gage railroad ties, household, office and school furniture, wood novelties,

etc.; and in addition cast light on the potentialities of local woods for pulp for paper, containers, and wallboards, interests of the P. R. Development Company.

3. Show the appropriate methods of silviculture to be practised in the natural or wild forest stands through improvement cuttings, commercial sales, and underplantings that will result in the best combination of the species most adaptable to various sites and of the greatest utilitarian qualities.

4. Develop sound techniques for nursery practice, field planting, and plantation care to be employed for the species selected, both native and exotic, according to the criteria for natural forests; and

5. Thus provide eventually, on all forest soils of the Island not more valuable for the higher uses of pasture or crop agriculture, fully stocked stands of composition and quality which fit both the environmental factors and the needs of the people and industries of Puerto Rico; and when that is accomplished it is envisaged that imports of forest products into the Island can be limited to those required only for very special purposes. If reasonably fast progress is to be made in reaching those goals, the present research appropriations ought to be doubled to continue and expand the presently authorized projects (see Project Status sheets) and to initiate the two new projects at an early date (Recommended Formally Authorized and Financed New Project sheets).

Two significant happenings during 1945, in addition to specific research accomplishments but vitally affecting forest research of the future, were (a) the realization by the Planning, Executive, and Legislative bodies of the Insular Government of the importance of and the public's role in public forest growing, farm forestry, and watershed protection and the practical recognition thereof in the form of new Insular Government appropriations of over $1,000,000; and (b) the organization of a Sub-committee on Forestry under the auspices of the Anglo-American Caribbean Commission and the planning of a truly Inter-Caribbean meeting solely on Forest Research, which was held and successfully concluded at Trinidad in January 1946.

(Signed)

ARTHUR UPSON
Director

STAND IMPROVEMENT

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Stand Improvement

Purpose: To develop practical methods for improving forest growth and quality by pruning, thinning, and other cultural treatment.

Review of Past Work: Cutting of all subordinate trees of 0.5 to 2.0" d.b.h. in young mangrove to supply small stakes proved unsatisfactory silviculturally because it failed to remove large misshapen trees or accelerate materially growth rate of remaining dominants. Observation led to conclusion that approximately 60 percent shade controls vines and weeds yet permits tolerant reproduction to develop in lower montane rain forest. Cutting should be confined to stands denser than this and should remove inferior trees to that point. A 20-year-old stand of Calophyllum calaba, thinned from 165 to 101 square feet of basal area per acre, yielded poles and fuelwood worth $285.00 per acre.

Accomplishments during Past Year: Young mangrove thinned to basal area of 38.5 sq. ft. per acre attained 96.85 sq. ft. in seven years. Eighty-two common forest trees were appraised as regards growth, form, and utility for use in marking timber.

Plans for Next Year: Establish thinning plots in pure plantations of Swietenia macrophylla and Montezuma speciosissima. Study pruning of Petitia domingensis. Current diameter growth measurement in thinned Calophyllum calaba plot.

Date of Completion: Continuing

Assignment: Wadsworth

SILVICS

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Silvics - Environmental Factors

Purpose: To determine silvical characteristics of valuable tree species as a basis for silviculture.

Review of Past Work: Growth records were started in twenty-one stands of distinct composition and structure, and records cover nearly 100 species in variety of crown classes. Intolerance of Tabebuia pallida and its temporary ecological role was found. Dominant trees grow 0.4" in dia. annually. Manilkara nitida was found under favorable conditions to attain diameter of 7" in 25 years.

Accomplishments during Past Year: Tolerant species, those of relatively slow growth in open, were found to be generally most rapid growing species in forest environment. In lower montane rain forest of Luquillo mountains two-year diameter growth for 940 trees (56 species) was 0.30". Considering average diameter growth of dominants (0.52") as 100%, codominants grew, 90%; intermediates, 60%; and suppressed trees, 27%. Seven percent of trees of stand are dominants, 11% codominants, 55% intermediates, and 27% suppressed. Only slight difference in growth rate in favor of dominants of intolerant species, while intermediate and suppressed tolerant species are growing much more rapidly than intolerant species in same environment conditions. Underplanting studies indicate that most species, however tolerant, do not make rapid early growth unless they are located beneath openings in canopy of from 4' to 12' in dia. depending upon canopy height. Annual growth in 20-year-old plantation of Calophyllum calaba was 0.4" for dominants, 0.3" for codominants, and 0.2" for intermediates.

Plans for Next Year: Re-examine plots in Luquillo mountains, at Guánica and Maricao, and in Rio Piedras and St. Just woodlots. Establish silvical and growth plot in Cambalache Experimental Forest (trees now tagged) and in upper forest of Luquillo mountains.

Date of Completion: Continuing

Assignment: Wadsworth

PLANTING STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Planting

Purpose: To develop improved planting methods, and to determine proper spacings, adaptability of species to site, and relative merits of planting of nursery or wilding stock vs. direct seeding.

Review of Past Work: Preliminary studies of planting methods and site adaptability were made with 92 species. Delay of 8 days between lifting and planting with five species kept moist did not adversely affect survival. Some species, including Swietenia macrophylla, may be safely so held 16 days. Tabebuia pallida, and Guarea trichilioides may be readily established with wildings. Wilding stock is generally cheap and survival of well rooted wildings is often higher than that of nursery stock. Dacryodes excelsa and Manilkara nitida should be planted only with ball of earth. Albizzia procera, Prosopis juliflora and Buchenavia capitata stock should be cut back to 1" to 3" after lifting.

Accomplishments During Past Year: Thirty-four new species were studied. Species successfully established only when planted with tar-paper pots (ball of earth) are Bucida buceras and Guaiacum officinale. Eight species of eucalyptus appear to be successfully established on five sites above 500' elevation using tar paper pots. Germination of direct seeded Stahlia monosperma in dry limestone region has been high. Prunus occidentalis found easy to propagate and to successfully underplant bare rooted at 2,000' elevation. Cordia alliodora has been successfully underplanted using wildings cut back to 3" high. Swietenia mahagoni was successfully direct seeded ~~under~~ light shade in dry limestone region, a cheap method producing trees of good form.

Plans for Next Year: Determine suitable species for improving composition of secondary forests on exposed ridges and other poor sites. Test direct seeding of Cedrela odorata. Study pot and stock size relationships to survival.

Date of Completion: Continuing

Assignment: Marrero, Wadsworth

NURSERY STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Nursery Studies

Purpose: To develop methods for economical production of planting stock with capacity for high survival following field planting.

Review of Past Work: Preliminary studies of sowing, spacing, lifting and other cultural treatments were conducted with 54 native and exotic species. Optimum tree spacing was found to be 3" x 6" for Albizzia procera, and Sciacassia siamea; 6" x 6" for Eucalyptus robusta and Vitex divaricata; and 1" x 6" for Casuarina equisetifolia. Root system of Casuarina equisetifolia stock is materially improved by transplanting, a practice most successful with trees 8" to 10" tall. Vitex divaricata is best produced in direct sunlight, while Guarea trichilioides requires about 50% shade. Dacryodes excelsa found difficult to propagate on coastal plain, even under partial shade, but does well in nurseries at 2,500' elevation. Seed of Manilkara nitida should be sown very shallow, or preferably in moist leaves, as it is not capable of pushing up through heavy soil. Discontinuing application of water to stock of Sciacassia siamea 1 month prior to lifting caused marked "hardening" of stock and higher field survival.

Accomplishments during Past Year: Stock growth records from all forest nurseries of island since 1924 were summarized for 48 species, including 3,159 sowings. Thirty-seven new species were propagated experimentally. Studies with 91 species to date leads to conclusion that on coastal plain almost no species prefer direct sunlight to partial shade during germination and first month of growth. Later direct sunlight is generally preferable, as it produces more woody stock. Optimum spacing for stock of Cordia alliodora was found to be 6" x 6". Seedlings of Bucida buceras two inches tall may be transplanted to pots with only light mortality. Direct application of 5% kerosene solution of DDT in form of spray to ant nests in vicinity of sowings of Casuarina equisetifolia has proven a satisfactory control method.

Plans for Next Year: Further study of DDT as an insecticide. Development of satisfactory transplant board for Casuarina equisetifolia. Continued study of shade-growth relationships.

Date of Completion: Continuing

Assignment: Marrero

SEED STUDIES

Field Division: Forest Management Research

Work Project: Regeneration

Line Project: Seed Studies

Purpose: To develop satisfactory methods of collection, extraction, storage and testing of seed to meet nursery and direct seeding requirements.

Review of Past Work: Studies of seed germination and storage were conducted with 105 species. Soaking of seed of Sciacassia siamea in concentrated sulfuric acid for 10 minutes shortened germination period from 60 to 10 days. Similar results were obtained for Ormosia krugii after 1 hour of treatment. Floating test in water was found suitable test for seed of Tetragastris balsamifera. Viability of seed of Swietenia macrophylla and Cedrela mexicana can be increased from 3 to 9 months by storage at 40°F. Successful storage period for seed of Cordia alliodora can be increased from 4 weeks to 3 months by desiccating to 25% of original moisture and sealed storage at 40°F. Seed of Manilkara nitida remains viable only one month at room temperature. Viability of seed of Montezuma speciosissima was increased from 2 weeks to 2 months by storage at 40°F when dried to 62% of natural moisture content.

Accomplishments During Past Year: Studies of seeds of 50 new species were made. Low germination in Bucida buceras is due to incomplete seed formation and insect attacks. Seed samples collected in October from young trees proved to be best large samples to date. Seeds of Guaiacum officinale are not mature until they turn orange, and cold storage is detrimental to retention of viability. Seed of Lucuma multiflora remains viable for only one month at room temperature. Tabebuia pallida seeds, normally viable only 2 months, stored at 40°F and 25% of original moisture content retained viability 25 months, contrary to indications of earlier studies. Nursery records since 1924 on rapidity of germination of 294 native and exotic species in 11,584 sowings were summarized.

Plans for Next Year: Study relationships between seed quality and parent tree in Bucida buceras, Magnolia splendens, M. portoricensis, and Hyeronima clusioides. Routine germination and weighing tests of available seeds of promising species not already tested.

Date of Completion: Continuing

Assignment: Marrero

TREE STUDIES

Field Division: Forest Management Research

Work Project: Mensuration

Line Project: Tree Studies

Purpose: To develop practical methods for rapid accurate measurement of tree volume, before and after cutting.

Review of Past Work: Board foot converting factors were developed for stakes, posts, poles, crossties and oxyokes. Form factor volume tables were prepared for Puerto Rican hardwoods by J. W. Girard in November 1944.

Accomplishments during Past Year: None

Plans for Next Year: Prepare cordwood volume tables for trees of Luquillo mountains. Determine weight per cord for dry and green faggots. Test Navy hypsometer in rain forest.

Date of Completion: Indefinite

Assignment: Wadsworth

STAND STUDIES

Field Division: Forest Management Research

Work Project: Mensuration

Line Project: Stand Studies

Purpose: To determine the growth, mortality, and yield of important forest types.

Review of Past Work: Yield from 8-year-old mangrove forest, cut to 3" dia. limit, was 3,452 posts of 2" to 3" dia. at small end and 10 cords of fuelwood, total stumpage value $183.00 per acre, or $23 per acre per year. Yield from 10-year-old plantation of Casuarina equisetifolia averaged 3.12 cords per acre per year. On favorable sites this species attains diameter of 9.5" in 10 years and 15" after 20 years. Coppice stands of Eugenia jambos when clear cut for charcoal yielded 20 to 25 cords per acre on an 8-year coppice rotation, or 2.5 to 3 cords per acre per year.

Accomplishments During Past Year: Thirty-acre plot was established in Cambalache Experimental Forest to provide, with other information, data on natural mortality.

Plans for Next Year: Measure 30-acre growth plot and determine yield from selective cutting in Cambalache Experimental Forest. Remeasure growth plots in Luquillo mountains, at Guánica and Maricao, and in St. Just and Rio Piedras woodlots. Establish growth plots in plantations of Tectona grandis, Swietenia macrophylla, and Cordia alliodora in Rio Abajo and Carite Insular Forests.

Date of Completion: Continuing

Assignment: Wadsworth

FARM WOODLANDS

Field Division: Forest Economics

Work Project: Private Forestry

Line Project: Farm Woodlands

Purpose: To determine practical means by which farm and community forests may be improved with little initial investment and to show extent to which private forestry can pay.

Review of Past Work: Early results at St. Just and Cambalache Experimental Forests (Woodlots) brought out great demand for faggots by dense rural population and possibilities of cheap forest improvement by merely marking inferior trees for them to take.

Accomplishments During Past Year: Granting permission to neighbors to remove dead fuelwood from 471-acre area at Cambalache is successfully cleaning up area and has not resulted in widespread trespass as had been feared by many. This area contributed dead fuelwood to 249 families during past two years. They abided by restrictions on cutting of live material, and have come to consider the forest "theirs" to such an extent that they assisted materially in apprehension of a trespasser. Receipts from timber sales in two years amount to $351.51. Vine cutting a necessary preliminary to sales, was found to cost $10.00 per acre, when done by crews.

Plans for Next Year: Encourage timber sales and make experimental cuttings to determine possible early yield under management as related to costs of administration, protection and management.

Date of Completion: A ten-year project. Will then continue as a demonstration area.

Assignment: Wadsworth

INVENTORY, YIELD, REQUIREMENTS

Field Division: Forest Survey

Work Project: Survey of Forest Resources, Present and Future Requirements.

Line Project: Inventory, Growth on Yield, Mortality, Requirements, Interpretation.

Purpose: To collect and interpret data on stands, growth, yield, mortality, and requirements as a basis for the preparation of plans of sustained yield management by the Federal Forest Service for the Caribbean National Forest, and by the Insular Forest Service for the Insular Forests.

Review of Past Work: Working circles were set up in the Caribbean Forest and minimum stumpage rates and board foot converting factors were computed. General marking rules were drawn up.

Accomplishments During Past Year: All available data on stands, types, and growth was analyzed from aerial photographs, maps, and timber survey data as a basis for a cutting budget prepared for the Caribbean Forest.

Plans for Next Year: Conduct an inventory of the Luquillo Division of the Caribbean National Forest, the synthesis of stand and growth data to provide information on yield, and the collection of historical, social, and economic background information for the preparation of a complete management plan.

Date of Completion: Luquillo management plan in 1947, Toro Negro in 1948, Insular Forests 1948 or later.

Assignment: Wadsworth

INTER-AMERICAN COOPERATION

Field Division: Forest Management Research

Work Project: General

Line Project: Inter-American Cooperation

Purpose: To advance forestry in the tropics of the Western Hemisphere through assistance and cooperation in common regional problems.

Review of Past Work: Trilingual quarterly technical forestry journal The Caribbean Forester, edited, published, and distributed free of charge throughout region since October 1939. Forestry Sub-committee set up in 1944 within Caribbean Research Council of Anglo-American Caribbean Commission with Tropical Station, holding membership. Memorandum of Understanding consummated in 1944 between B.W.I. and Station under which former colonies now making token contributions for enlarged editions of Caribbean Forester. Surveys of forest resources were conducted in Costa Rica, Ecuador, and Chile. Preparation of a Spanish-English glossary of forestry terminology started, with English terms extracted from glossary of Society of American Foresters and similar material.

Accomplishments during Past Year: Plans made for meeting of Forestry Sub-committee at Port-of-Spain, Trinidad in January 1946 to discuss regional forest research problems and needs. Caribbean Forester published with articles from British Honduras, Colombia, Chile, Ecuador, Trinidad, Cuba, and Martinique. Three-hundred-seventy Spanish forestry terms have been found in literature and defined.

Plans for Next Year: Modify research program where necessary to make greatest contribution to solution of regional forestry problems as determined at Trinidad meeting. Continuation of publication of The Caribbean Forester. Advancement of glossary work and publication of 100 English-Spanish synonyms with definitions.

Date of Completion: Glossary, at least three years. Balance of project continuous.

Assignment: Upson, Wadsworth, García-Piquera

Recommended Formally Authorized and Financed Project

SILVICS

Field Division: Forest Management Research

Work Project: Silviculture

Line Project: Silvics - Tree Distribution, Dendrological Studies

Purpose: To identify and to facilitate identification of trees of Caribbean region; to standardize common and scientific nomenclature; and to determine natural distribution of and to describe forest associations of the region.

Review of Past Work: Approximate original location of seven primary forest types of Puerto Rico has been determined. Herbarium of about 1,500 specimens of tree species of Caribbean region has been accumulated. Ink drawings of specimens of 325 trees of Puerto Rico have been prepared, and 100 of these were published with descriptions in English and Spanish. List of native arborescent species of Puerto Rico were extracted from flora and checked by office of dendrologist in Washington to assure that it conforms with International System of Nomenclature. Natural areas have been established in dry forest at Guánica and in humid forest of western mountains at Maricao for ecological study. Protected areas are located in wet mountain forests in both Luquillo and Toro Negro Divisions of Caribbean Forest and in dry limestone type in Cambalache Experimental Forest. Relatively undisturbed forest on lower slopes of Luquillo mountains was studied in 1.8-acre sample plot and found to contain 40 to 50 species per acre. Dominant species, Dacryodes excelsa, makes up 34% of basal area. No other species makes up more than 6%.

Accomplishments During Past Year: Ninety new specimens were mounted for herbarium. Total of 480 new sheets were received from Costa Rica, Ecuador, Curacao, and British West Indies.

Future Needs: Continue collection of herbarium specimens. With assignment or detail of an Ecologist-Dendrologist any or all of following work might be done: (1) location and description of local forest associations in accordance with Beard's scheme, (2) preparation of four volumes of Trees of Puerto Rico with publication of two in 1946, (3) preparation of vegetative key to native tree species, and (4) preparation of accurate check list of local trees, using latest accepted nomenclature.

Duration of Project: Two to three years

Recommended Formally Authorized and Finanoed Project

UTILIZATION OF PUERTO RICAN WOODS

Field Division: Forest Products

Work Project: Forest Utilization

Line Project: Forest Utilization

Purpose: To determine the present and potential local requirements and uses for and the more ordinary properties of Puerto Rican grown woods; to provide an avenue of contact between the Station and Forest Products Laboratory; to furnish a technical utilization service to specifiers and consumers of wood; and to conduct simple wood tests as time affords.

Review of Past Work: Untreated Sloanea berteriana heartwood was found resistant to teredos 18 months in San Juan harbor. Fence posts of the following species normally last less than 2 years in service under rainfall in excess of 100 inches: Cordia sulcata, Rapanea ferruginea, Heterotrichum cymosum, Ocotea leucoxylon, Myrcia deflexa, Laguncularia racemosa, Avicennia nitida, and Alchornea latifolia. Inga laurina, and Casearia arborea posts were serviceable 3 years. Lateral penetration of 3/4 to 2 inches resulted from 6-hour hot and cold bath carbolineum treatment of Casuarina equisetifolia.

Accomplishments During Past Year: A preliminary study and report of wood utilization in Puerto Rico were made by Messrs. Teesdale and Girard for the Puerto Rico Development Co. Hot and cold bath treatment of 3-inch posts of Didymopanax morototoni with carbolineum gave complete penetration after 2 hours at 212°F. Approximate oven-dry specific gravities were determined for 106 native and 3 exotic woods. The average was found to be 0.70. From these data, using the formulae of Markwardt and Wilson, factors were found for compression parallel to and perpendicular to grain, static bending, impact bending, and hardness. Approximate green moisture content of the sapwood of 28 native woods were determined. These moisture contents, based on oven-dry weight, varied from 44 to 372 percent. Testing of 203 seasoned samples of 81 local woods showed the equilibrium moisture content at Rio Piedras to be 14.6 percent. Two mangrove species, Avicennia nitida and Laguncularia racemosa, contained 19.0 and 18.3 percent respectively, indicating that the presence of salts in these woods may influence moisture content.

Future Needs: Maintenance of service records of small studies now in progress and the establishment of an Utilization Unit at the Station for the purposes outlined above.

Duration of Project: Continuous

LIST OF PUBLICATIONS AND PAPERS

Upson, Arthur

Forests and Land Tenure in Puerto Rico. Paper presented at Land Tenure Conference, September 1944, Mayaguez. 6 pp. to be published by Caribbean Research Council of Anglo-American Caribbean Commission.

The Experience of the Forest Service in its Land Purchase Program. Paper presented at Institute on Land Value Problems, November 1945, Mayaguez. To be published by the Office of the Governor.

Wadsworth, Frank H.

The Potentialities of Forestry on Mona Island. Caribbean Forester, Vol. 6 (4), 219-244.

Further Notes on the Regeneration and Growth of Tabebuia pallida Miers. Caribbean Forester, Vol. 6 (4), 267-270.

El Bosque Experimental de Cambalache, un Beneficio para la Comunidad. Revista de Agricultura (in press).